DOCUMENT RESUME

ED 119 864 PS 008 446

AUTHOR	Rubin, Rosalyn A.; And Others
TITLE	The Relationship of Apgar Scores to Neonatal Survival and Later Development: A Review. Interim Report No. 19.
INSTITUTION	Minnesota Univ., Minneapolis. Dept. of Psychoeducational Studies.
SPONS AGENCY	National Inst. of Education (DHEW), Washington, D.C.
BUREAU NO	BR-6-1176
PUB DATE	Mar 75
NOTE	16p.
EDRS PRICE	MF-$0.83 HC-$1.67 Plus Postage
DESCRIPTORS	*Child Development; Cognitive Development; *Evaluation Methods; Infant Mortality; *Infants; Intelligence Tests; *Measurement Instruments; Motor Development; Neurological Defects; *Physical Health; *Predictive Validity; Preschool Education
IDENTIFIERS	*Apgar Score; Birth Weight; Educational Follow Up Study; Neonates

ABSTRACT

This paper presents a review of the literature concerning the infant Apgar scoring system and its relationship to later mental and motor development. Since 1952, the Apgar scoring system has provided a viable means of assessing the infant's immediate postnatal condition. Researchers have demonstrated that while the 1-minute Apgar score is a useful indicator of the infant's postnatal condition, it does not seem to have the same strength as the 5-minute Apgar score which appears to provide a more sensitive indicator of the newborn's condition during the neonatal period. In addition, the Apgar system of assessment has been tentatively accepted as a basis for the prediction of later mental and motor development. The 5-minute score appears to be a more accurate predictor than the 1-minute score in regard to later development of the child. Further research (such as the ongoing Educational Follow Up Study) will help to determine the extent to which neonatal Apgar scores may be predictive of later language development, academic achievement, and school behavior. (Author/BRT)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

ED119864

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

INTERIM REPORT #19

Project No. 6-1176

Grant No. OEG-32-33-0402-6021

RELATIONSHIP OF APGAR SCORES TO NEONATAL SURVIVAL AND LATER DEVELOPMENT: A REVIEW

March, 1975

PS008446

U.S. DEPARTMENT OF

HEALTH, EDUCATION, AND WELFARE

National Institute of Education

INTERIM REPORT #19

Project No. 6-1176

Grant No. OEG-32-33-0402-6021

RELATIONSHIP OF APGAR SCORES TO NEONATAL SURVIVAL AND LATER DEVELOPMENT: A REVIEW

Rosalyn A. Rubin, Bruce Balow, and Carol Hara

Department of Psychoeducational Studies

University of Minnesota

Minneapolis, Minnesota

March, 1975

The Research reported herein was performed pursuant to a grant from the National Institute of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of this project. Points of view or opinions stated do not, therefore, necessarily represent official National Institute of Education position or policy.

U.S. DEPARTMENT OF

HEALTH, EDUCATION, AND WELFARE

National Institute of Education

Abstract

Relationship of Apgar Scores to Neonatal Survival and Later Development: A Review

Rosalyn A. Rubin, Bruce Balow, and Carol Hara

University of Minnesota

There is strong evidence that the Apgar scoring system provides a viable means of assessing the infant's immediate postnatal condition. Researchers have demonstrated that while the one-minute Apgar score is a useful indicator of the infant's postnatal condition, it does not seem to have the same strength as the five-minute Apgar score which appears to provide a more sensitive indicator of the newborn's condition during the neonatal period. In addition, it has been tentatively accepted that the Apgar system of assessment provides a basis for the prediction of later mental and motor development. The five-minute score appears to be a more accurate predictor than the one-minute score in regard to later development of the child. Further research such as that underway in the Educational Follow-Up Study will help to determine the extent to which neonatal Apgar scores may be predictive of later language development, academic achievement, and school behavior.

Relationship of Apgar Scores to Neonatal Survival and Later Development: A Review

Rosalyn A. Rubin, Bruce Balow, and Carol Hara

University of Minnesota

Prior to 1952, methods of assessing the condition of the neonate included first breathing time, which was defined as "the time from the delivery of the head to the first respiration;" or crying time, described as the time until the establishment of a satisfactory cry (Apgar, 1953, p. 260). However, according to Apgar, breathing time is difficult to judge because anesthesia used during the delivery process may cause the newborn to gasp once and then become apneic for several minutes. To facilitate a more accurate and objective assessment of the neonate, Apgar in 1952 developed a five-item scoring system which included these vital signs: heart rate, respiratory effort, reflex irritability, muscle tone, and color. The maximum score an infant can receive is 10; a score of 7-10 is considered good, a score of 4-6 is considered fair, and a score of 3 or less is regarded as poor. Typically, the neonate is assessed at one, two, and five minutes after birth; but assessment continues at later estabished time periods if the condition of the newborn warrants it.

Studies conducted by Apgar (1953), Apgar and James (1962) and Drage et al. (1964, 1966a, 1966b) have demonstrated that the Apgar scoring system is a viable method of distinguishing the "at risk" neonate. To illustrate, in 1953 Apgar conducted a study based

on 1021 newborns which demonstrated an inverse relationship between Apgar scores and infant mortality. Fourteen percent of the neonates who had one-minute scores of 0-2 did not survive the neonatal period, while only 1.1% with Apgar scores of 3-7, and .13% with scores of 8-10 died.

In a later study of 15,348 subjects, Apgar, Holaday, James, Weisbrot and Berrien (1958) found that infants with a one-minute score of 5 or more had a good probability of neonatal survival, while newborns with a score of 4 or less had a sharp increase in mortality.

There are several factors associated with the delivery of the neonate which appear to depress the child's Apgar score. Several investigators (Apgar, 1953; Apgar & James, 1962; Auld et al, 1961; Barrie, 1962) found that breech deliveries, the use of mid forceps, emergency cesarean section delivery, or an abnormally prolonged first (>12 hours) or second (>1 hour) stage of labor tended to lower the average Apgar score assigned to the neonate.

Characteristics of the newborn which are associated with reduced Apgar scores are: low birth weight, erythroblastosis, nuchal coils, fetal heart rate greater than 160 or irregular, and diabetes in the mother.

In regard to birth weight, Apgar and James (1962) found that within the birth weight groups of 1001-1500 gms, 1501-2000 gms, 2001-2500 gms, and 2500 gms or more, there was a highly significant difference ($p<.001$) in survival between infants whose one-minute score was poor (0-3), fair (4-6) or good (7-10). They also found that the Apgar score had minimal prognostic value among infants with a birth weight

of less than 1000 gms because the majority of these children did not survive the neonatal period.

Another issue which has been explored is whether Apgar scores have predictive efficacy in regard to the later physical and mental development of the child. Shipe, Vandenberg, and Williams (1968) proposed that since infants with low Apgar scores have an increased mortality rate, it is also plausible, according to Pasamanick's hypothesized continuum of damage, that children with low Apgar scores who survive the neonatal period would evidence a greater incidence of minimal neurological and intellectual impairment. All infants who had one-minute Apgar scores of less than 5, and who were born between February 1, 1962 and February 28, 1963 at Louisville General Hospital were included in a study to evaluate this proposal. These subjects were matched on race, sex and birth weight with controls who had Apgar scores of 5 or more. When the subjects were 30 months of age, 33 pairs were given the Pacific Multifactor Battery and the Vineland Social Maturity Test. At 36 months of age the Stanford Binet, Form L-M was administered to 24 matched pairs and 17 unmatched subjects. The mean IQ for the low Apgar subjects was 86.9, which was not significantly different from the mean IQ score of 87.5 attained by the control subjects. Shipe et al. concluded that low one-minute Apgar scores were not related to poor performance on later IQ tests.

Krusen (1971) investigated the relationship between physical condition at birth, as assessed by the Apgar scoring system, and

intellectual functioning at school age. The sample included 95 Caucasian subjects for whom one-minute Apgar scores were available. Between the ages of 4 years, 8 months and 6 years, 6 months, each of the subjects was administered the Wechsler Preschool and Primary Scale of Intelligence (WPPSI). Krusen hypothesized that there would be a significant positive correlation between the Full Scale WPPSI and the one-minute Apgar score. However, this hypothesis was not confirmed. The correlation coefficient of .06 between Apgar scores and WPPSI performance was not significantly different from zero. Krusen did not report results of comparing the mean IQ for the entire group with the standardized national norms for the WPPSI. Nevertheless, Krusen maintained that these findings demonstrated that the Apgar score had little value in regard to estimating later intellectual functioning.

Several factors may account for the lack of relationship between Apgar scores and later intellectual functioning found by Shipe et al. (1968) and Krusen (1971). First, the subject pools included in these studies had few cases with Apgar scores of less than two. In the study conducted by Krusen, 79% of the cases had Apgar scores of 8 or more; 20% had scores of 3-7; while only 1% (one subject) had scores of 2 or less.

Perhaps the primary reason Shipe et al. and Krusen failed to find a significant relationship between the Apgar score and later intellectual functioning was that these investigators used the one-minute Apgar score. It is hypothesized that, while the one-minute Apgar score effectively indicates the infant's condition

at birth and his chances for survival through the neonatal period, the five-minute Apgar score is thought to have greater predictive efficacy in regard to later development (Drage et al., 1969).

The Apgar system for evaluating neonates was adopted by the Collaborative Project for the Study of Cerebral Palsy, Mental Retardation, and Other Neurological and Sensory Disorders of Childhood in an effort to investigate the newborn infant's early state as it relates to preceding conditions of pregnancy, labor and delivery, and to subsequent development of the child (Drage & Berendes, 1966a). Infants in the Collaborative Project were scored at one, two, and five minutes of age on each of the subscales of the Apgar index; if an infant did not achieve an Apgar score of 8 at five minutes, he was assessed again at 10, 15, and 20 minutes of age.

Utilizing Collaborative Project data, Drage and Berendes (1966a) conducted a study (n = 17,221) relating the Apgar score to birth weight, infant mortality, and the incidence of neurological abnormalities at one year of age. Twenty-three percent of the infants with Apgar scores of 0 or 1 on the one-minute measure did not survive the neonatal period; 49% of the infants receiving comparable scores on the five-minute measure failed to survive the first 27 days of life. As the Apgar scores increased the percentage of neonatal deaths decreased; also, proportionally more of the infants with low five-minute Apgar scores failed to survive the neonatal period.

Regarding birth weight, 57.2% of the infants weighing less than 1501 gms had one-minute Apgar scores of 0-3, while only 5.3% of the infants weighing 3001-3500 gms had similar scores. Of the infants who had five-minute Apgar scores of 0-3, 77.9% of those weighing less than 2001 gms died, while 15.4% of those weighing more than 2501 gms failed to survive the neonatal period. Drage and Berendes concluded that an inverse relationship exists between Apgar score and mortality overall, and between Apgar score and mortality within each birth weight group, though low birth weight tends to accentuate the relationship between Apgar score and infant mortality.

At one year of age, 14,115 subjects were individually administered a neurological examination and classified as normal, neurologically suspect, or neurologically abnormal. For this analysis Drage and Berendes (1966a) combined into one group those infants classified as normal or suspect. Of the infants who received one-minute Apgar scores of 0-3, 3.6% were classified as neurologically abnormal; 7.4% receiving five-minute scores of 0-3 were similarly classified. Among infants who received five-minute Apgar scores of 3 or less, 18.8% weighing 2000 gms or less, 12.5% weighing 2001-2500 gms, and 4.3% weighing 2501 gms or more were classified as neurologically abnormal.

Drage and Berendes thus concluded that both low birth weight and low Apgar scores were associated with an increased incidence of neurological abnormalities. In addition, the five-minute Apgar score was more closely associated with neonatal mortality and morbidity than the one-minute Apgar score.

Drage, Kennedy, Berendes, Schwarz and Weiss (1966b) conducted a study using Collaborative Project data relating the Apgar score to motor retardation at one year of age. They found that, irrespective of birth weight, the highest proportion of motor retardation was seen in children with a five-minute Apgar score of 3 or less. They also found higher percentages of children considered to have motor retardation who had lower five-minute Apgar scores than those with lower one-minute Apgar scores. They thus concluded that the five-minute Apgar score is a more useful predictor of neurological impairment and motor retardation.

In addition, they found that low birth weight was associated with an increase in the percentage of children considered retarded in motor development. The trends between birth weight, Apgar score, and motor retardation are illustrated in Table 1 (Drage et al., 1966b).

Table 1

Percent of Children Demonstrating Retardation in Motor Development[1]

	Five Minute Apgar Score		
Birth weight (gms)	0-3	4-6	7-10
1001 - 2000	22.2	28.6	13.4
2001 - 2500	20.0	4.9	4.5
≥ 2501	4.3	3.4	2.4

1. Information obtained from portion of Table II in Drage, et al 1966b, p. 143.

A follow-up of the Collaborative Study subjects was conducted by Drage, Berendes, and Fisher (1969) when the children reached the age of four years. All children with malformations of the central nervous system, Down's Syndrome, or hypothyroidism were excluded from

the study. At age four 18,038 subjects (8,503 Caucasian; 9,535 Negro) were administered the Stanford Binet, Form L-M. Birth weight was dichotomized into categories of subjects weighing less than 2500 gms, and those weighing 2500 gms or more. Subjects were also divided into high and low groups on the basis of Apgar scores of 8-10 and 0-6 respectively. The results are illustrated in Table 2 (Drage et al., 1969):

Table 2

Mean Four-Year IQ Scores for Caucasian and Negro Subjects[1]

	Five-Minute Apgar Score				
	0 - 6 (low)		8-10 (high)		
Birth Weight (gms)	N	$\bar{X}$	N	$\bar{X}$	p
Caucasian					
<2500	45	100.1	414	102.1	n.s.*
≥2500	280	101.8	7764	105.2	<.001
Negro					
<2500	153	87.1	930	89.6	<.05
≥2500	365	91.3	8087	92.3	n.s.*

[1]Taken from portions of Tables 2 and 3 in Drage et al., 1969, pp. 223-224.
*n.s. = not significant

Drage, Berendes, and Fisher concluded that for Caucasian subjects weighing 2500 gms or more at birth and for Negro subjects weighing less than 2500 gms there were significant differences in mean IQ between the high and low Apgar groups. For the other birth weight groups--Caucasian subjects weighing less than 2500 gms and Negro subjects weighing 2500 gms or more--there were no significant differences between the two Apgar groups, though there was a tendency

for children with high Apgar scores to obtain higher IQ scores. They therefore posited that the five-minute Apgar score has predictive power with respect to later intellectual development.

Edwards (1968), using Collaborative Project subjects of which the majority were of lower SES, investigated the relationship between the physiological condition of the neonate and the child's development at four years of age. Edwards proposed that (a) one- and five-minute Apgar scores and birth weight were related to the child's four-year performance on tests of intelligence, conceptual abilities, and fine and gross motor coordination, and (b) the correlations between the Apgar score and four-year measures of development would be stronger for fine and gross motor coordination than for intellectual conceptual abilities.

At four years of age, 147 subjects, for whom one- and five-minute Apgar scores were available, were administered various psychological examinations, including: the Stanford Binet, Form L-M; the Graham-Ernhart Block Sort Test; and measures of fine and gross motor coordination.

Edwards found that as the Apgar scores became progressively lower, IQs, scores on concept formation, and fine and gross motor coordination tended to decline. Also, correlations between Apgar scores and fine and gross motor coordination were higher than correlations between Apgar scores and IQ, or Apgar scores and concept formation. Edwards concluded that physical condition at birth is related to the child's development at four years of age. Further, that the five-minute Apgar score tended to account for more

of the variance on the four-year measures than did the one-minute Apgar score.

Thus, there is strong evidence that the Apgar system of evaluating newborns provides a viable means of assessing the infant's immediate postnatal condition. Researchers (Drage et al., 1964, 1966a, 1966b, 1969; Edwards, 1968) have demonstrated that while the one-minute Apgar score is a useful indicator of the infant's postnatal condition, it does not seem to have the same strength as the five-minute Apgar score, which appears to provide a more sensitive indicator of the newborn's condition during the neonatal period. In addition, it has been tentatively accepted that the Apgar system of assessment provides a "theoretical basis for the prediction of future mental and musculoskeletal development" (Krusen, 1971, p. 4). The five-minute score appears to be a more accurate predictor than the one-minute score in regard to later development of the child.

Further research such as that currently underway under the auspices of the Educational Follow-Up Study will help to determine the extent to which neonatal Apgar scores may be predictive of later language development, academic achievement and school behavior.

References

Apgar, V. A proposal for a new method of evaluation of the newborn infant. Current Research in Anesthesia and Analgesia, 1953, 32, 260-267.

Apgar, V., Holaday, D., James, L., Weisbrot, I., & Berrien, C. Evaluation of the newborn infant: Second report. Journal of the American Medical Association, 1958, 168, 1985. Cited in Barrie, H., Developmental Medicine and Child Neurology, 1962, 4, 128-132.

Apgar, V., & James, L. Further observations on the newborn scoring system. American Journal of Diseases of Children, 1962, 104, 419-428.

Auld, P., Rudolph, A., Avery, M., Cherry, R., Drorbaugh, J., Kay, J., & Smith, C. Responsiveness and resuscitation of the newborn. American Journal of Diseases of Children, 1961, 101, 713-724.

Barrie, H. The Apgar evaluation of the newborn infant. Developmental Medicine and Child Neurology, 1962, 4, 128-132.

Drage, J., Kennedy, C., & Schwarz, B. The Apgar Score as an index of neonatal mortality. Obstetrics and Gynecology, 1964, 24, 222-230.

Drage, J., & Berendes, H. Apgar scores and outcome of the newborn. The Pediatric Clinics of North America, 1966, 13(3), 635-643. (a)

Drage, J., Kennedy, C., Berendes, H., Schwarz, B., & Weiss, W. The Apgar score as an index of infant morbidity. Developmental Medicine and Child Neurology, 1966, 8, 141-148. (b)

Drage, J., Berendes, H., & Fisher, P. The Apgar scores and four-year psychological examination performance. Perinatal Factors Affecting Human Development, 1969, 185, 222-227.

Edwards, N. The relationship between physical condition immediately after birth and mental and motor performance at age four. Genetic Psychology Monographs, 1968, 78, 257-289.

Krusen, M. The relationship of physical condition at birth to intellectual functioning at early school age. (Doctoral dissertation, University of Nebraska, 1971). Dissertation Abstracts International, 1971, 32(5), 2485-A. (University Microfilms No. 71-28,628)

Shipe, D., Vandenberg, S., & Williams, R. Neonatal Apgar ratings as related to intelligence and behavior in preschool children. Child Development, 1968, 39, 861-866.